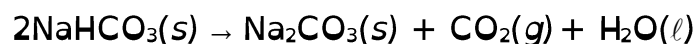


ANSWERS: Decomposition

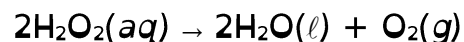
1) The white NaHCO_3 would heat and form a white powder of Na_2CO_3 . Water vapour would also form and may be seen as a colourless liquid on the insides of the tube.

The CO_2 can be collected and bubbled into limewater, which would go milky to confirm that CO_2 is produced.

OR blue cobalt paper could be used to test the colourless liquid. If it is water, the paper will turn pink.



Hydrogen peroxide is a colourless liquid, which decomposes slowly to form O_2 and H_2O , but with MnO_2 acting as a catalyst to speed up the reaction, there is vigorous bubbling to produce O_2 gas.



Both reactions show the initial substance decomposing to form more than one substance.

Reaction 1 is an example of a thermal decomposition reaction.

Reaction 2 is the catalytic decomposition of hydrogen peroxide where MnO_2 speeds up the rate at which H_2O_2 breaks down.

2) When white calcium carbonate solid, CaCO_3 , is strongly heated it releases a colourless gas, carbon dioxide, CO_2 , and forms another white solid calcium oxide, CaO .



When white calcium hydroxide solid, $\text{Ca}(\text{OH})_2$, is strongly heated it releases a colourless gas, water, H_2O , and also forms the white solid calcium oxide, CaO .



Comparisons:

Both calcium carbonate and calcium hydroxide are undergoing thermal decomposition since a solid is decomposing to form more than one substance when heated. Both are white solids and when strongly heated, they both form another white solid, calcium oxide. During heating, both of the solids break up because gas escapes from them.

Contrast:

The difference in these reactions is in the gases released.

Calcium carbonate releases carbon dioxide, so a loop of limewater (calcium hydroxide in solution) will turn milky (or cloudy white) when held in the gas / carbon dioxide will extinguish a burning splint.

Calcium hydroxide releases steam or water as a gas / vapour. A piece of cobalt chloride paper held in this gas will turn from blue to pink.

3) This is an example of a thermal decomposition reaction where the copper carbonate is heated and it decomposes to form more than one substance. The green CuCO_3 powder would heat and change colour to form a black powder of CuO . There would possibly be some 'jumping' of the powder as a colourless gas CO_2 forms and then escapes the tube. The CO_2 can be collected and bubbled into limewater which would go milky and confirm that CO_2 is produced. CO_2 can be collected, and a burning splint, when introduced, would go out (CO_2 does not support combustion). Adding sulfuric acid to the black CuO powder will cause a blue solution (CuSO_4) to form to show Cu^{2+} is present.



4) After MnO_2 (black / dark brown solid) is added to the colourless H_2O_2 solution, bubbles of colourless gas are formed rapidly. The solution remains colourless. The black / dark brown solid remains.

This is a catalytic decomposition where hydrogen peroxide decomposes / breaks down to form H_2O and O_2 gas (two smaller products). Manganese dioxide (MnO_2) is used as a catalyst to speed up the rate of the reaction.

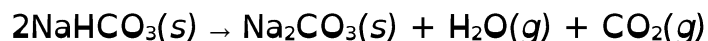
The MnO_2 causes the colourless H_2O_2 solution to decompose more rapidly to form colourless O_2 gas / bubbles of O_2 gas and colourless H_2O .



5)



This goes from blue to a black powder, and condensation (a colourless liquid) may form. The condensation can be tested with cobalt chloride paper which will turn from blue to pink. Na_2CO_3 does not decompose so no colour change will be observed and no gases will be formed.



NaHCO_3 is a white powder that will decompose to form a white powder. Two gases will form. (Or condensation (a colourless liquid) may form.) One will turn limewater milky / extinguish burning splint / turn damp blue litmus red, and the other would turn cobalt chloride paper from blue to pink.

6) Products formed:

Copper oxide and carbon dioxide

Observations:

The green copper (II) carbonate powder turns black and loses mass when heated. The powder appears to be a boiling liquid as a gas is released.

Use of limewater:

Limewater is used to positively identify the presence of carbon dioxide gas, CO_2 . Limewater is calcium hydroxide (Ca(OH)_2). Insoluble calcium carbonate forms, turning limewater milky. $\text{Ca(OH)}_{2(aq)} + \text{CO}_{2(g)} \rightarrow \text{CaCO}_{3(s)} + \text{H}_2\text{O}_{(l)}$

Fate of carbonate ions:

Breaks down into carbon dioxide gas and an oxide ion (forming copper oxide with the copper.)

Decomposition Equation:



7) Catalyst:

manganese dioxide OR potassium iodide OR animal liver OR potato OR Iron III oxide.

Description of observations:

When the catalyst is added to the colourless hydrogen peroxide solution, bubbling is observed as a gas is released. The reaction mix heats up. The volume of gas produced is high initially but slows down over time.

Amount of catalyst:

A catalyst is a chemical that speeds up the rate of a reaction but which is not consumed by the reaction. (As the catalyst is constantly being reused only a small amount is required.)

Catalytic decomposition over time:

The decomposition of hydrogen peroxide with a catalyst occurs very quickly at first, with a lot of oxygen gas released in a short period of time. As the reaction proceeds, there is less hydrogen peroxide available to react so less oxygen gas is able to be produced. (The rate of the reaction slows.) Until eventually almost all / all of the hydrogen peroxide has decomposed and no more oxygen will be produced.

8)

| Carbonate | Colour before heating | Colour after heating | Gas evolved | Ease of decomposition |
|------------------|-----------------------|--------------------------------------|----------------|-------------------------------------|
| Sodium carbonate | white | white | none | (Very) difficult /doesn't decompose |
| Zinc carbonate | white | White (when cool)/ yellow (when hot) | Carbon dioxide | easily |
| Copper carbonate | green | black | Carbon dioxide | (Very) easily |

The carbonates that can be thermally decomposed form similar products. They form metal oxides and carbon dioxide. The oxide loses mass as a gas (carbon dioxide) is lost. For example white zinc carbonate powder when heated forms yellow/white zinc oxide and carbon dioxide gas:



And when green copper carbonate powder is heated it forms black copper oxide and carbon dioxide gas:



We know the gas formed is carbon dioxide because the limewater will turn milky/cloudy. White sodium carbonate powder does not decompose on heating so there will be no change. The white powder will remain

9) As it is heated, the copper(II) carbonate decomposes to form copper(II) oxide, which is a black powder, and carbon dioxide. (Which is unlikely to be seen as it is a colourless gas.) The observation given (burning splint goes out) indicates that a gas is given off that does not support combustion. This gas is the carbon dioxide.



10) Copper(II) hydroxide, when heated, undergoes thermal decomposition. It is broken down into copper(II) oxide and water. Solid blue copper(II) hydroxide turns into a black solid when heated. It has formed copper(II) oxide, CuO, (accept powder or crystals in lieu of solid). The blue cobalt chloride paper turned pink because water vapour / gas is formed in this reaction.



11) calcium carbonate → calcium oxide + carbon dioxide

12) (a) Thermal decomposition

(b) The zinc hydroxide is a white powder. When heated, the white powder turns yellow and as it cools turns white, this is zinc oxide. Condensation (a colourless liquid) may form on the side of the test tube/steam forms (not gas or water vapour). A loss in the mass of the solid may be noticed.

13) Sodium carbonate : white powder

Calcium carbonate : white powder

Copper carbonate : green powder

(i) Sodium carbonate: no reaction / still a white powder.

(ii) Calcium carbonate: gas given off / no apparent change

(iii) Copper carbonate: gas given off / powder turns black.

(If CO₂ gas = accept. Do not accept CO₂ on its own – this is an inference not an observation.) (Accept effervescence.)



14) lead hydroxide → lead oxide + water

15) copper hydroxide → copper oxide + water

16) The green solid turns black/brown. Limewater turns milky.

